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REVIEW OF LITERATURE

The review of literature pertaining to the study **"Effect of Functional Foods and Lifestyle Modification Strategies on Hypertensive Men and Women in Coimbatore, Tamil Nadu"** is discussed under the following titles.

A.Prevalence of Hypertension – A global view

B. Hypertension and its risk factors

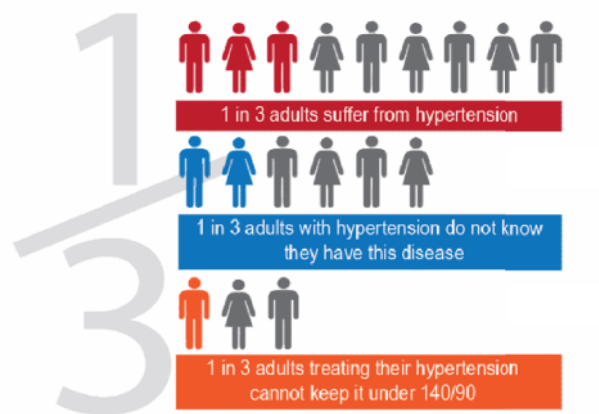
- **a. Unmodifiable risk factors**
- **b. Modifiable risk factors**

C. Alternative method of treatment for hypertension

- **a. Dietary approach to hypertension**
- **b. Yoga and hypertension**

A.Prevalence of Hypertension – A global view

Hypertension is an important medical and public health issue all over the world. It has been identified as the leading risk factor for mortality, and is ranked third as a cause of disability-adjusted life years. It is one of the most important preventable causes of premature death worldwide and contributes to 75 per cent of all stroke and heart attacks. The world health organization has concluded that hypertension is the major factor responsible for the most deaths worldwide (12.8 per cent per year or more than seven million). It places stress on several organs, including the kidneys, eyes and heart causing them to deteriorate over time. Risk of complications or rapid progression of hypertension become more likely in the presence of other risk factors, including significant elevation of blood pressure, increasing age, smoking, abnormal cholesterol, family history of premature heart disease, obesity, diabetes, coronary artery disease and other evidence of vascular disease. (Iqbal, 2011).



Hypertension is the leading risk factor for death worldwide and affects both men and women. Although 30 per cent of the adult population suffers from blood pressure above 140/90 mm Hg, a third of those who suffer it do not know they have this disease. One in three people being treated for hypertension fail to keep their blood pressure below 140/90 mm Hg (WHO, 2015).

It is an important risk factor for cardiovascular disease and affects almost one-third of the U.S. adult population. According to National Health and Nutrition Examination Survey, 2011–2012, the age-adjusted prevalence of hypertension among U.S. adults aged 18 and over is 29.1 per cent in 2011–2012. The prevalence of hypertension is similar for men and women at nearly one-third. The prevalence increases with age and is highest among older adults. Among adults with hypertension, nearly 83 per cent are aware, nearly 76 per cent are taking medication to lower their blood pressure, and nearly 52 per cent are controlled. The percentage of control is higher for women and older adults (Nwankwo *et al*., 2013).

In England, the prevalence of hypertension in 2012 was 31 per cent among men and 27 per cent among women, remaining at a similar level over the last few years. Between 2003 and 2012, the proportion of the population with controlled hypertension increased from five per cent to nine per cent among men, and from six per cent to nine per cent among women, a slight decrease from 11 per cent and 10 per cent respectively in 2011.The proportion of adults with untreated hypertension decreased from 2003 to 2012 for both sexes. Whilst the proportion of women with untreated hypertension is about the same as 2011 the proportion of men has risen slightly resulting in a slight increase in the overall figures which had maintained a steady decline since 2003 (hscic, 2013)

In developed countries of the world, the prevalence of hypertension is beginning to stabilize or decrease by the prevention and control measures.

Parallelly the prevalence rates of Cardio Vascular Disease (CVD) are also beginning to fall. In contrast, in the developing regions of the world such as South East Asian (SEA) and African region hypertension and CVD rates continue to rise. Extensive epidemiological studies show that hypertension is one of the commonest cardiovascular ailments in African region and SEA regions. Approximately one-third of the adult population has high blood pressure and nearly 1.5 million deaths occur due to hypertension each year in the SEA region (Mohan *et al*., 2013).

A recent systematic analysis of health examination surveys and epidemiological studies in 199 countries and territories with 786 country-years and 5.4 million participants has looked at the national, regional, and global trends in systolic blood pressure (SBP) for adults 25 years and older since 1980. The systolic blood pressure rose in Oceania, East Africa, and South and Southeast Asia for both sexes and in West Africa for women, with the increases ranging from 0.8 to 1.6 mm Hg per decade in men and 1.0 to 2.7 mm Hg per decade in women (Danaei *et al*., 2011).

High blood pressure was almost non-existent in African societies in the first half of the twentieth century, estimates now show that in some settings in Africa more than 40 percent of adults have hypertension. The prevalence of hypertension has increased significantly over the past two to three decades. There were approximately 80 million adults with hypertension in sub-Saharan Africa in 2000 and projections based on current epidemiological data suggest that this figure will rise to 150 million by 2025. Further, there is evidence that indicates that related complications of hypertension, and in particular stroke and heart failure are also becoming increasingly more common in this region. These trends have been strongly linked with changes in individual and societal lifestyle such as an increase in tobacco use, excessive alcohol consumption, reduced physical activity and adoption of "Western" diets that are high in salt, refined sugar and unhealthy fats and oils (Vijver *et al.,* 2013).

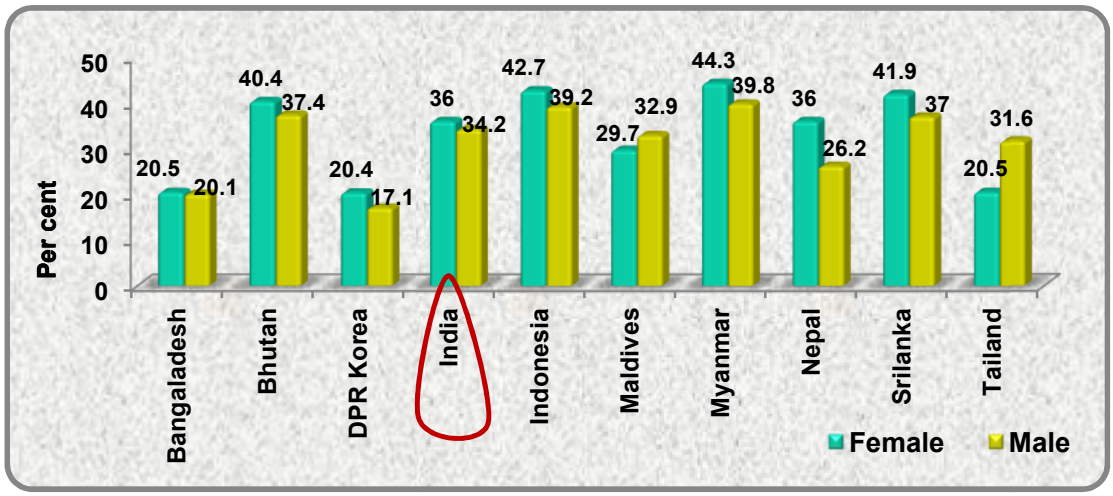
According to 40 studies in western Africa, the prevalence ranged from 12.0 per cent among automobile garage workers to 68.9 per cent among traditional chiefs. Typically sedentary workers such as traders, bank workers, civil servants,

and chiefs were at high risk. Among health care workers, the prevalence ranged from 17.5 to 37.5 per cent. The prevalence increased with age and was higher among males and workers with higher socio-economic status (Bosu, 2015).

In China, the overall prevalence of hypertension rose substantially between 2002 and 2010 – from around 20 per cent to 34 per cent. Unfortunately, the management of hypertension in China has been ineffective for many years. In 2010, for example, only 35.7 per cent of hypertensive individuals were aware of their condition and fewer than 18 per cent of such individuals were effectively controlling their hypertension. It has been estimated that hypertension was associated with 20 per cent of the deaths recorded in China in 2005, including 2.33 million – nearly 80 per cent – of the deaths from cardiovascular disease. Hypertension not only causes premature death; it may also add to household costs. In a study conducted in rural China, for example, it was estimated that 4.1 per cent of households suffered impoverishment as a result of hypertension (Feng *et al*., 2014).

Prevalence of hypertension is increasing in many countries in the SEA Region. In India, raised blood pressure increased from 5 per cent in the 1960s to nearly 12 per cent in 1990s, to more than 30 per cent in 2008. In Indonesia, the percentage of adult population with raised blood pressure increased from 8 per cent in 1995 to 32 per cent in 2008. In Myanmar, the Ministry of Health reported an increase in high blood pressure prevalence, from 18 per cent to 31 per cent in males and from 16 per cent to 29 per cent in females during 2004-2009. Ageing population, rapid urbanization and transition from agrarian life to a wage-earning modern city life are reported as major contributors to increased blood pressure in urban areas (WHO, 2013).

Krishanan *et al*., (2013) quotes that as per WHO age -standardized estimates of the prevalence of hypertension in countries of the SEA Region in 2008 table, India located in fourth place by recording the hypertension prevalence rate as 36 per cent in male and 34.3 per cent in female and the overall prevalence is 35.2 per cent. Age-standardized prevalence of raised blood pressure in adults aged 25+years, South –East Asia Region, 2008 is shown below.



Source: WHO, Non communicable diseases in the South-East Asia Region: Situation and response 2011, New Delhi, World Health Organistion 2011.

According to Directorate General of Health services, Ministry of Health and Family Welfare, Government of India, the overall prevalence of hypertension in India by 2020 will be 159.46/1000 population. In a meta-analysis of 34 epidemiological studies from rural and urban populations of India, it was observed that hypertension is emerging as a major public health problem in India and is more prevalent among urban people compared to those of rural areas (Pawar *et al*., 2010).

When it comes to hypertension prevalence, rural India is not far behind its urban counterpart. WHO report in India 2005, states that prevalence of hypertension was increased by about 30 times among urban community people and by about 10 times among the rural community people (Kokiwar *et al*., 2012).

A region specific (urban and rural par of north, east, west and south India) systematic review and meta-analysis of the prevalence, awareness and control of hypertension among Indians reveal that the overall prevalence for hypertension in India is 29.8 per cent. Regional estimates for the prevalence of hypertension were as follows: 14.5 per cent, 31.7 per cent, 18.1 per cent and 21.1 per cent for rural north, east, west, and south India; and 28.8 per cent, 34.5 per cent, 35.8 per cent and 31.8 per cent for urban north, east, west and south India respectively. Overall estimates for the prevalence of awareness, treatment and control of blood pressure

are 25.3 per cent, 25.1 per cent and 10.7 per cent for rural Indians and 42.0 per cent, 37.6 per cent and 20.2 per cent for urban Indians (Anchala *et al*., 2014).

Multiple cross-sectional studies conducted across various regions of India such as Delhi 10.5 per cent, south Chennai 7.5 per cent, Thiruvananthapuram 8.6 per cent, Assam 18.1 per cent and Mumbai 13.6 per cent indicate sub-optimal blood pressure control (Mohan *et al*., 2013).

Reddy *et al*., (2007) report high prevalence of hypertension in a study among industrial populations at multiple sites in India. A recent study in Mumbai shows that there is very low awareness of hypertension in the study subjects. Extrapolation of the awareness status to the hypertensive group reveals that only 6.1 per cent males and 10.1 per cent females are aware of hypertension (Gupta *et al*., 2011).

A community based cross sectional study was conducted in 48 villages and 15 urban wards of Jabalpur district of Central India say that the prevalence of hypertension was 17 per cent with 21.4 per cent in the urban population and 14.8 per cent in the rural population. Significantly higher mean values of weight, height, BMI, hip circumference, waist circumference, waist hip ratio, systolic blood pressure, fasting blood sugar and serum cholesterol levels were mapped in the urban population in comparison with the rural population (Bhadoria *et al*., 2014)

Shukla *et al*., (2014) observed that out of total 3629 eligible participants in western India, 1735 (48 per cent) were ≤40 years of age. The overall prevalence of hypertension and prehypertension was 26 per cent and 40 per cent, respectively. The prevalence of hypertension was approximately 11 per cent in the age group ≤40 years whereas in the older population (>40 years) it was found to be 40 per cent.

Gupta *et al*., (2010) stated that studies among the less acculturated Indian tribal show only a small increase in hypertension prevalence. But Laxmiah *et al*., (2015) observed high prevalence of hypertension even among tribals in India. The prevalence of hypertension among them after age adjustment was 27.1 and 26.4

per cent among men and women, respectively. It was higher in the States of Odisha (50-54.4 per cent) and Kerala (36.7-45 per cent) and lowest in Gujarat (7-11.5 per cent). The risk of hypertension was 6-8 times higher in elderly people and 2-3 times in 35-59 yr compared with 20-34yr. Only <10 per cent of men and women were known hypertensives and more than half on treatment (55-68 per cent).

A large-scale study undertaken recently in rural Tamil Nadu has confirmed the high prevalence. It was observed that 21.4 per cent hypertension prevalence in about 10,500 people (aged 25-64) in 11 villages in the State. Prevalence was nearly the same in both sexes. If the higher prevalence in rural population is bad enough, a large percentage of people remaining ignorant of their condition is indeed a major cause for concern. About 75 per cent of people with hypertension were ignorant of their condition. It was more in the younger age group. Unlike older people who may become aware of their hypertension status when visiting healthcare facilities for other conditions, younger people are less likely to suffer from major illnesses and hence less likely to visit doctors. So, it is less likely to detect their elevated blood pressure. The proportion of people (both males and females) whose hypertensive status was newly diagnosed decreased with age and awareness of the condition. According to the study about 24.5 per cent of deaths in people aged 45-59 years in rural Tamil Nadu are caused by diseases of the circulatory system. This study indicated hypertension is an emerging public health problem in rural population in Tamil Nadu (Prasad, 2012).

The data of more than 2000 subjects from the CURES study in chennai, South India revealed that overall prevalence of hypertension in the study population was 20 per cent being in 23.2 per cent in men and 17.1 per cent in women. Even in the young (20 -29 yrs) the prevalence of hypertension was 3.8 per cent in men and 3.1 per cent in women, while at the age of 60 years and above the figures jumped to 50.8 per cent in men and 51 per cent in women. Isolated systolic hypertension was present in 6.6 per cent of the subjects while isolated diastolic hypertension was present in 4.2 per cent of the subjects. Among the known hypertensive subjects, 70.8 per cent were under treatment for hypertension

however only 45.9 per cent had blood pressure under control, which represents 15.4 per cent of the total hypertensive group (Joshi *et al*., 2007).

A cross sectional study was conducted on 400 geriatric population at Attayampatti village, rural community in Salem district observed that the overall prevalence of hypertension was 59 per cent. Among hypertensives the prevalence in male was 33.3 per cent and in female it was 26.2 per cent. The mean BP was 140/100 (Radhakrishnan *et al*., 2013).

According to The Hindu, (2013), ICMR-INDIAB study provides data states that 11.3lakh individuals have hypertension in the Coimbatore district, with 3.6 lakhs men and 4.7 lakh women being obese.

Hypertension is rising very steeply in India to the extent of 20 to 40 percent annually. It's a red alert for the country. The most disturbing fact is that as many as 60 percent of those having hypertension are not at all aware that they are suffering from high blood pressure. Besides, 42 percent of the population suffers from uncontrolled hypertension despite medication. (The times of India, 2015).

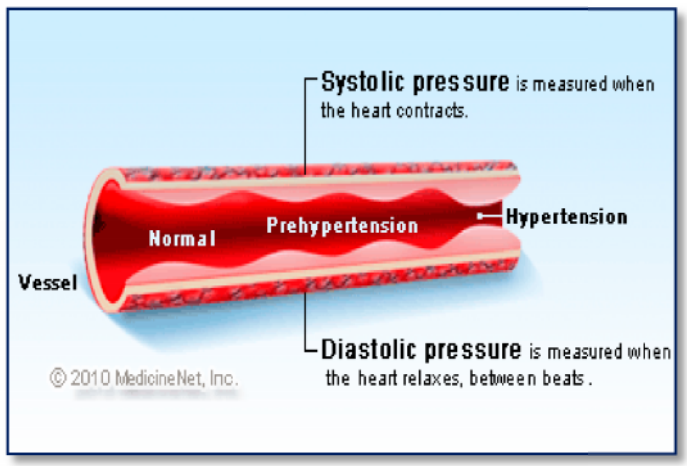
The increasing hypertension epidemic in India portrays an urgent need to develop suitable population based strategies to prevent hypertension and associated risk factors. Finding suitable prevention method in turn helps to trim down the global Non Communicable Disease (NCD) burden.

Hypertension and its risk factors

Blood pressure

Blood pressure is a measurement of the force exerted upon blood vessel walls by blood as it flows through the arteries. Since the heart has distinct “beats”, the pressure of oxygenated blood in the arteries is not continuous, but varies between two values, one when the heart is contracting, and one when the heart is relaxing. As the heart contracts, blood is expelled from the left ventricle under the greatest force; this upper pressure limit is the *systolic* blood pressure. Following contraction of the heart, the aortic valve closes, which prevents blood from flowing

backward into the heart, and helps maintain pressure in the arteries. This allows the heart muscle to relax and fill with blood. Blood pressure during the heart's "resting" period between contractions, called diastole, must be sufficient to deliver an adequate supply of oxygenated blood to cardiac tissue (www.lifeextension.com, 2015).



Systolic and Diastolic blood pressure
Source: www.emedicinehealth.com

Blood pressure is regulated by an intricate system of hormonal controls and nerve sensors, and it may vary considerably during the course of a day. Typically, blood pressure is low when at resting or asleep, and higher when moving about or under stress. The kidneys work in several ways to help regulate blood pressure. The kidneys also produce renin, an enzyme that plays a key role in regulating blood pressure (Mosser, 1992).

Blood pressure is influenced by balance of vasoconstrictor and vasodilator effectors. Vasoconstrictor effectors include angiotensin II, norepinephrine, vasopressin, and endothelin, while vasodilator effectors include prostaglandins, nitric oxide, and bradykinin. The autonomic nervous system also affects BP regulation, with the sympathetic system acting to stimulate the heart and constrict blood vessels, and the parasympathetic system acting to depress cardiac function and dilating selected vascular beds (Black, 2010).

Essential hypertension or idiopathic hypertension or primary hypertension accounts for 95 per cent of all cases of hypertension. Essential hypertension is a heterogeneous disorder, with different patients having different causal factors that lead to high BP. Although it has frequently been indicated that the causes of essential hypertension are not known, it can be influenced by number of un-modifiable and modifiable risk factors (Carretero and Oparil, 2000).

a. Un-modifiable risk factors

Genetics

Babies born to parents who have hypertension tend to have higher-than-average or more variable blood pressures throughout infancy and childhood, and are more likely to develop hypertension at a relatively early age. This tendency strongly suggests that there is a genetic basis for at least some cases of high blood pressure (Mosser, 1992).

There are large number of genes that are responsible for hypertension. Single-gene related hypertension is, however, rare. Intermediate phenotypes are more important and prevalent than gene mutations. These phenotypes are body-fat distribution, familial dyslipidemia, metabolic syndrome, insulin resistance, kallikreen deficiency, sodium sensitivity, non modulation of aldosterone and renal blood flow, abnormal cellular ion transport systems (Na, Li, K, H transport system) and blood pressure reactivity. (Gupta *et al*., 2013).

Bernard *et al*., (2012) states that genetic variants in the gene encoding angiotensinogen, adrenomedullin, apolipoprotein, and alpha-adducin have been reported to be associated with common conditions such as diabetes, hypertension, dysglycemia, or metabolic syndrome. In Hong Kong studies of single nucleotide polymorphisms (SNPs), SNPs that predict development of diabetes were found also to predict the development of hypertension.

Choi *et al.,* (2011) have indentified two novel genetic mutation that can trigger hypertension in up to a third of patients suffering from a common cause of severe high blood pressure. In hypertensive population, the MTHFR gene C677T mutation homozygous may be the important genetic factors to elevated homecysteine and H-high blood pressure and exist gender differences (Zhong *et al*., 2010).

Myeloperoxidase gene polymorphism was associated with susceptibility of essential hypertension in Chinese population (Fang *et al*.,2009).The ADD1 gene G460W polymorphism and eNOS gene G894T polymorphisms are associated with essential hypertension in Mongolia (Wang *et al*., 2007).

Ethnicity

Hypertension prevalence differs in different ethnic groups. South Asians (Asian-Indians) have an increased CHD risk, potentially related to the metabolic syndrome, primarily due to insulin resistance, truncal obesity and dyslipidemia. In the Indian subcontinent, hypertension is a major public health concern, and among south Asians living in western societies, the prevalence of hypertension, along with CHD, will potentially increase with time. Some explanation of the various hypertension rates among Asian populations may be related to sodium intake and decreased physical activity (Ferdinand and Ferdinand, 2008).

Lambers (2005) quotes that Bangladeshi men and women had lower mean systolic and diastolic BP than Indian and Pakistani men. Prevalence of hypertension was less common in Bangladesh in both men and women than in Indian and Pakistani groups.

Khan and Beevers (2005) states that the pathophysiology of hypertension differs in black adults compared to South Asians and whites. Hypertension in this population is commonly of the low renin type, sensitivity of blood pressure to salt intake is often increased, and the ability to excrete ingested salt is impaired (60–70 per cent). This leads to an overall expansion of intravascular volume. Obesity is especially prevalent in black women and is associated with an increase in total body sodium content. Black patients may also have relatively higher concentrations of intracellular calcium. All of these factors are associated with an increased incidence of hypertension.

According to Holmes *et al.,* (2013), there are statistically significant differences exists in the prevalence of hypertension by race/ethnicity with respect to income, education, marital status, smoking, alcohol, physical activities, body mass index, and age. He states that race/ethnicity is a single independent predictor of hypertension.

A study by Carson *et al.,* (2013) states that hypertension incidence was higher for blacks compared with whites between 45 and 74 years of age but not after age 75 years. In a south London community based study, compared with

whites, age and sex standardised prevalence ratios for hypertension were 2.6 in people of African descent and 1.8 in those of South Asian origin. However, average blood pressure varies between different subgroups of South Asians, being highest in Sikhs, similar to whites in Muslims, and intermediate in Hindus.

Age and gender

The association between increasing age and increasing systolic blood pressure is thought to reflect the length of time people are exposed to modifiable risk factors. For any given age up to 65 years women tend to have a lower blood pressure than men. After 65 years, this trend is reversed. The cause is unknown. Prevalence also increases progressively with age. Results from the Framingham study demonstrate that in middle aged and elderly persons, the residual lifetime risk of developing hypertension is 90 per cent. It is clearly recognized that an increasing blood pressure level is associated with a greater risk of heart attack, stroke, and kidney disease. (Rafey, 2013).

The long term follow up studies of the multiple risk factor intervention trial have revealed that for the most patients it is the SBP rather than the DBP that most strongly predicts adverse events. Additionally most persons with hypertension, especially those >50 years of age, will reach the DBP goal once the SBP goal is achieved, so the primary focus should be on attaining the SBP goal (Hackam, 2010).

According to Calhoun *et al*., (2008) in 45 – 74 year old American Indians, the risk of developing hypertension are rising. As older age and obesity are 2 of the strongest risk factors for uncontrolled hypertension, the incidence of resistant hypertension will likely increase as the population becomes more elderly and heavier.

Isolated systolic hypertension is the most common form of hypertension in the elderly and is associated with increased risk of cardiovascular morbidity and mortality as compared with systolic-diastolic hypertension or isolated diastolic hypertension (Larstorp *et al*., 2012).

b. Modifiable risk factors

Over weight and obesity

Obesity is an independent risk factor for cardiovascular disease including hypertension, coronary heart disease and heart failure and is associated with an increased risk of morbidity and mortality. It is the most important risk factor of primary hypertension (Masuo *et.al*., 2011 and Luo *et al*., 2010).

The prevalence and severity of hypertension increase with increasing BMI. Obesity, and especially abdominal obesity, is the hypertensinogenic factor. A direct association between hypertension and BMI has been observed in cross-sectional and longitudinal population studies form early childhood to old age. A BMI of <25 is considered normal or healthy, whereas a BMI of 26 to 28 increases the risk of high BP by 180 per cent and the risk of insulin resistance by >1000 per cent. Thus insulin resistance is present in many patients with obesity and hypertension (Carretero *et al*., 2000).

Obesity is characterized by various hemodynamic and metabolic abnormalities, in circulating blood volume and systemic circular resistance, which contribute to the development of hypertension. Therefore, hypertension associated with obesity is characterized by combined volume and pressure overload. Typically, hypertension via increased peripheral arterial resistant / after load leads to ventricular wall thickening without chamber dilation, which is classified as concentric remodeling or as concentric Left Ventricular (LV) hypertrophy when there is an increase in LV mass. On the other hand, obesity with elevated circulating blood volume leads to an increase in LV mass via chamber dilatation without a significant increase in wall thickness, a process that is referred to as eccentric LV hypertrophy. Recently, in a study from a large echocardiographic database, demonstrated that the high prevalence of abnormal LV geometric patterns in obese patients. Different types of obesity were closely related to the prevalence of hypertension (Jian *et al*., 2010).

The risk of hypertension in individuals with central obesity is high than those with normal waist circumference within three Body Mass Index categories (Zhang *et al*., 2013).

A 10kg increase in body weight was associated with an increase of 3 and 2.3 mm Hg in systolic and diastolic blood pressure, respectively. These increases translated into an estimated 12 per cent increased risk for CHD and 24 per cent increased risk for stroke. Also, results from NHANES III indicated that the prevalence of hypertension increased progressively with increasing BMI, from 15 per cent at BMI, 25 kg/m2 to 42 per cent of 30 kg/m2 in men and from 15 per cent at BMI, 25 kg/m2 to 38 per cent at a BMI of 30 kg/m2 in women (Schutter *et al*., 2011).

Kenchaiah *et al*., (2002) estimated that the risk of Heart failure increases 5 per cent for men and 7 per cent for women for each increase of 1unit in BMI. In fact, a graded increase in the risk of heart failure was observed across all categories of BMI, suggesting a casual relationship between excess body weight and the development of heart failure.

In a study of 74 morbidity obese patients, nearly one-third had clinical evidence of heart failure, and the probability of heart failure increased with increasing duration of morbid obesity. At 20 and 25 years of obesity duration, the probability of heart failure was 66 per cent and 93 per cent respectively. Obesity typically causes worsening in cardiac relaxation which is a common cause of heart failure. Moreover obesity over a period of time is associated with reduced LV systolic function (Artham *et al*., 2009).

Physical inactivity

Physical inactivity is strongly positively associated with hypertension, and intervention studies have demonstrated that increased physical activity is effective in the treatment of high blood pressure in a variety of populations (Durrani and Fatima, 2014).

Inverse associations between physical activity and/or cardiorespiratory fitness and incident hypertension have also been reported amongst various international populations in Britain, China, Denmark, France, Italy, Korea, Saudi Arabi, and Thailand in recent years (Thomas *et al*., 2012).

Wang *et al*., (2014) state that many studies show the relationship between physical inactivity and hypertension in India. A study observes a statistically significant association between hypertension and leisure time physical inactivity. Odds ratio is found to be 2.51 indicating the absence of leisure time physical activity which is twice the risk of hypertension when compared with positive leisure time physical activity. Some researchers have proved that long-term aerobic exercise regimens have beneficial effects upon systolic blood pressure

Hypertension is skyrocketing in India, with rural-to-urban migrants at especially high risk. The key lifestyle factors that promote hypertension are sedentary habits and diet. When people migrate from rural areas to urban areas they increase their weight, measured as body mass index (BMI, kg/m2), and they increase their waist size. This is clearly due to changing lifestyles – they become more sedentary and their diet changes (Gupta, 2013).

Nayak *et al*., (2013) opines that physical inactivity is proven to be an important risk factor for non communicable diseases like diabetes, hypertension, obesity, cancer etc. He observes higher prevalence of physical inactivity and different patterns by gender and age, with elder person are more physically active than the younger, further, age related declines in physical activity is much more frequently observed among males than females in Ahamedabad.

Physical activity levels are generally lower in Industries that were located in highly urbanized metropolitan cities such as Delhi, Hyderabad and Bangalore and are higher in predominantly semi-urban settings such as Assam and Nagpur and is intermediate in other areas (www.searo.who.int/india).

Sleeping pattern

Reflecting changing lifestyles, people are sleeping less in modern societies. Getting adequate sleep is essential to preventing health conditions such as obesity

and diabetes as well as several risk factors for cardiovascular disease including sleep –disordered breathing and night time hypertension. Sleeping less than seven and a half hours per day may be associated with future risk of heart disease. In addition, a combination of little sleep and overweight elevated blood pressure appears to be associated with an increased risk of the disease. Patients with shorter sleep duration plus an overweight increase in blood pressure had a higher incidence of heart disease than those with normal sleep duration plus no overnight increase in blood pressure. (Eguchi, 2013).

Excess alcohol intake

In cross sectional and prospective epidemiological studies, higher blood pressure has consistently been found among persons reporting usual daily intake of three standard-sized drinks or more. Heavier drinking may, in fact, be the commonest cause of reversible hypertension and reduction of heavy alcohol intake plays an important public health role in hypertension management (Klatsky and Gunderson, 2008)

Alcohol consumption has been reported to be associated with hypertension independently of age, race, sex, obesity, smoking, salt intake and socio economical factors. Excess alcohol intake could cause a rise in blood pressure and can induce resistance to antihypertensive therapy and also increase risk of stroke (Shanthirani *et al*., 2003).

According to a study by Alexandros *et al*., (2012) confirmed that irrespective of sex, heavy alcohol intake increases hypertension risk. He found that the association between light to moderate alcohol intake and the risk of developing hypertension differed among women and men. Light to moderate alcohol consumption modestly lowered hypertension risk, whereas heavier consumption of >20 g／d significantly increased hypertension risk.

Anand (2010) states that excess alcohol consumption are reported to account for 5-30 per cent of all hypertension. A study of 277 hypertensives shows that amongst beer drinkers, 38 per cent are hypertensives and amongst spirit drinkers, 56 per cent of hypertensives.

Smoking and tobacco chewing

Tobacco use is the most common cause of avoidable cardiovascular morality worldwide (Teo *et al*., 2006). There are now 1.3 billion cigarette smokers, 82 per cent in developing countries, and if current practices continue, there will be an estimated one billion tobacco-related deaths during the 21st century. The immediate noxioius effects of smoking are related to sympathetic nervous over activity, which increases myocardial oxygen consumption through a rise in blood pressure, heart rate and myocardial contractility (Najem *et al*., 2013).

Smoking causes an immediate increase in blood pressure and heart rate that persists for more than 15 minutes after one cigarette. People who smoke show higher ambulatory blood pressure levels than non-smokers. Within two years of quitting, the risk of coronary heart disease is substantially reduced, and within 15 years the risk of CVD returns to that of a non-smokers (www.worldheartfederation.org)

The incidence of hypertension is increase among those who smoke 15 or more cigarettes per day, and the coexistence of hypertension and smoking decreases left ventricular function in asymptomatic people (Kalpana *et al*., 2015).

Elevated blood pressure and smoking are the two most important risk factors for subarachnoid haemorrhage in the Asia-Pacific region. The risk of myocardial infarction is 2-6 times higher and the risk of stoke is three times higher in people who smoke, compared with non-smokers (Huang *et al*., 2008).

Cigarette smoking results in impairment of endothelial function, arterial stiffness which may persist for a decade even after smoking cessation, inflammation, lipid modification as well as an alteration of antithrombotic and prothrombotic factors are smoking-related major determinants of initiation, and acceleration of the atherothrombotic process, leading to cardiovascular events. Hypertensive smokers are more likely to develop severe forms of hypertension, including malignant and renovascular hypertension, an effect likely due to an accelerated atherosclerosis (Virdis *et al*., 2010).

In an experimental study, acute use of pan-masala (an indigenous concoction of lime, areca nut, catechu, etc.) has been shown to significantly increase blood pressure. These findings emphasize that smoking-tobacco cessation should be important component of hypertension control strategy. This is true not only in India, but world-wide, where hypertension is increasing significantly in both urban and rural populations (Gupta *et al*., 2012).

Salt intake

Salt is the major source of sodium which is the risk factor of hypertension. Salt or body sodium level is considered to be one of the important contributing factors in the pathogenesis of hypertension (Misra and Khurana, 2008).

The sodium intake induces hypertension by increasing fluid volume and preload, thereby increasing cardiac output. Numerous authoritative scientific reviews that have critically examined this association have confirmed the harmful health impact of excess salt consumption, particularly on cardiovascular health, and unequivocally recommended salt reduction. Worldwide, excess dietary salt intake is responsible for 17 per cent–30 per cent of hypertension and substantially increases the risk of blood pressure-related CVD events in normotensives. A recent study from rural Andhra Pradesh reports a high salt intake of 42.3 g/day/person. Although most information apart from the aforementioned study are not contemporary, these data indicate a high level of intake compared to the WHO recommended intake level of 5 g/day and the National Institute of Nutrition's (NIN) recent Recommended Dietary Allowances (RDA) for Indians of 5–6 g/day (Mohan and Prabhakaran, 2013).

Radhika *et al*., (2007) assessed salt intake in urban Chennai adults using food frequency questionnaire and found it to be 8.5 g/day. Both systolic and diastolic blood pressure significantly increased with increase in quintiles of total dietary salt both among hypertensive and normotensive subjects. Addition of salt >1 teaspoon/day at the dining table was associated with a higher prevalence for hypertension compared to zero added salt.

The present average sodium intakes in various industrialized populations are very high, that is 2-3 fold in comparison with the current Dietary Reference Intake (DRI). By contrast, the present average potassium, calcium and magnesium intakes are remarkably lower than the recommended intake levels. The high sodium on one hand and the low intakes of potassium, calcium and magnesium on the other hand, produce and maintain elevated blood pressure in a big proportion of the population (Karppanen *et al*., 2005).

Devi (2013) observed that almost half of Maharastra's population, that is 47.4 per cent is prehyperensive and at risk of developing full-fledged hypertension if ignored. One of the reasons for this high affliction was changes in the dietary habits. Aggressive media fuelled the easily available high salt content foods among the population and the traditional food habits among Maharastra promoted high salt content foods.

The current high –salt intake of 9 to 12g/dl is the major factor increasing blood pressure (He *et al*., 2012) and a blood pressure can be lowered through reduced salt intake in hypertensive patients (Matyasa *et al*., 2011). High dietary sodium intake is associated with an increased incidence of stroke and with increased risk of death due to coronary heart disease or cardiovascular disease. Reduction of salt intake has been shown to be beneficial - in the Trials of Hypertension Prevention (TOPH) studies I and II, involving 2,382 individuals with pre-hypertension; the risk of a cardiovascular event was 25-35 per cent lower in participants who adhered to sodium-restriction when compared to the control group (Jamaican, 2009).

Reducing dietary sodium by approximately 1700 mg (75 mmol) per day can lower systolic blood pressure by 4-5mmHg in hypertensive individuals and 2mm Hg in normotensive individuals. This may reduce the need for antihypertensive drugs.. However, it may still turn out to be significant as even small reduction in blood pressure may lead to substantial reduction in mortality (Fristoli, 2011).

Potassium intake

Potassium is an essential nutrient that is needed for maintenance of total body fluid volume, acid and electrolyte balance, and normal cell function. Primary

hypertension results from the interplay of internal derangements (primarily in the kidney) and the external environment. Sodium, the main extracellular cation, has long been considered the pivotal environmental factor in the disorder. Numerous studies show an adverse effect of a surfeit of sodium on arterial pressure. By contrast potassium, the main intra cellular cation, has usually been viewed as a minor factor in the pathogenesis of hypertension. However, abundant evidence indicates that a potassium deficit has critical role in hypertension and its cardiovascular sequel (Adrogue and Madias, 2007).

In the pre-agricultural and post-agricultural diets of our human ancestors, potassium intake was very high, often exceeding 200 mmol/day. In modern society, these levels have been markedly reduced. Food processing reduces the potassium content of food, and a diet high in processed foods and low in fresh fruits and vegetables is often lacking in potassium. Data from around the world suggest that the average potassium consumption in many countries is below 70-80 mmol/day, the value recommended by the 2002 Joint World Health Organization (WHO)/Food and Agriculture Organization Expert Consultation, and even fewer countries report an average consumption of 90 mmol/day as recommended by countries such as the United Kingdom, Spain, Mexico, and Belgium. No countries report an average population consumption of 120 mmol/day as recommended by the United States, Canada, Republic of Korea, and Bulgaria. Lower potassium consumption has been associated with elevated blood pressure, hypertension, and stroke, and higher levels of consumption could be protective against these conditions (Huang *et al*., 2008).

Various evidences suggest that the altered sodium and potassium homeostasis play a key role in pathogenesis of hypertension. According to the World Health Organization, the sodium-to-potassium ratio should be ≤1 (Aburto, 2013).

Potassium is a crucial mineral for restoring healthy blood pressure balance in body and when there is no enough potassium, symptoms can start to emerge that may eventually be diagnosed and labeled as “high blood pressure”. The sudden death can occur in fasting, anorexia nervosa or starvation is often a result

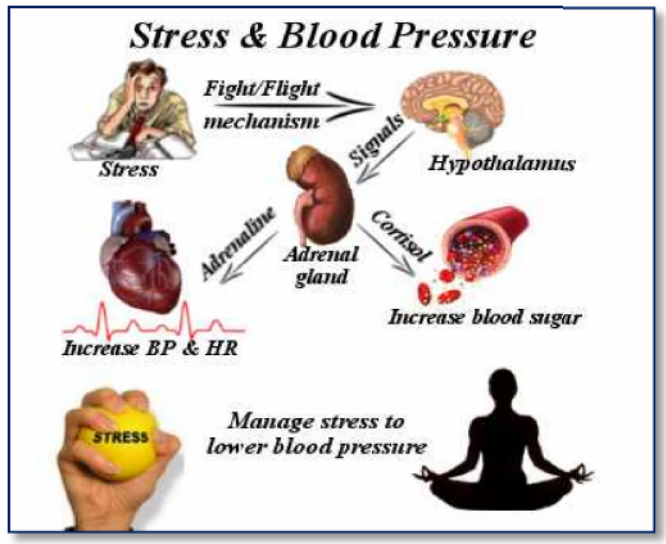
of heart failure caused by potassium deficiency. Many population studies have found links between low potassium intakes and an increased risk of high blood pressure and death from stroke. Increasing the amount of potassium rich foods in the diet can lead to a reduction in high blood pressure. The sodium to potassium in the diet appears to play an important role in the development of high blood pressure. The effects of either low potassium or high potassium can be life-threatening. Since potassium is necessary to the healthy functioning of nerves, cells and membranes, it is an important electrolyte to monitor (Adams, 2009).

A study by Zhang *et al*., (2013) observes that the average usual intakes of sodium, potassium and sodium-to-potassium ratio are 3,569 mg/d, 2,745 mg/d, and 1.41, respectively in 10,563 participants aged ≥20 years. All three measures are significantly associated with systolic blood pressure. This result provides population-based evidence that concurrent higher sodium and lower potassium consumption are associated with hypertension.

According to Brown *et al*., (2009) potassium is more effective in reducing blood pressure at higher levels of sodium consumption, and the largest benefit is detected when sodium intake was more than 4 g/day, which is the intake of most populations globally, so increased potassium intake should benefit most people in most countries.

Stress

Chronic emotional and mental stress is a big contributor to high blood pressure. That's because stress causes a sustained increase in the activity in the sympathetic nervous system—the part of the nervous system associated with the fight-or-flight response. When the sympathetic nervous system is activated, it floods blood with cortisol and adrenaline, accelerating the heart rate, constricting the blood vessels and increasing blood pressure. To lower the blood pressure naturally, one of the best things is to reduce stress by manipulating sympathetic nervous system activity with techniques to calm the system, defuse emotional anxiety and promote optimal physical and mental balance (Sinatra, 2015)



Stress and blood pressure
Source: www. healthy-ojas.com

Hypertension and related complications remain among the main problems in contemporary medicine and clinical psychology. In recent years a stable tendency of cardiologic disease to grow younger has been noted. The tendency is usually related to the penetrating effect of stress on modern society, while most able and vigorous people fall prey to it. Nowadays an increasing number of patients have been identified whose blood pressure indices at work are higher than during free time. This hypertension form was called “hypertension at work”. Hypertension at work today is found to be one of the most frequent forms of stress-induced hypertension. Many specialists find it possible that occasional episodes of blood pressure increase under stress in individuals with genetic and psychological predispositions may cause structural changes in the heart and blood vessels and result in constant hypertension (Yury *et al*., 2013).

In the prospective research “Whitehall Study”, conducted under the aegis of the WHO, a sample of 10308 managers reveals that restricted freedom in decision making in professional activity (workers of low- and mid-level) is accompanied by a higher risk of developing ischemic heart disease, both in men and women (Chandola *et al*., 2008).

Gasperin *et al*., (2009) conducted a systematic review followed by a meta-analysis aiming to assess the effect of psychological stress on blood pressure increase. Results show that individuals who had stronger responses to stressor tasks are 21 per cent more likely to develop blood pressure increase when compared to those with less strong responses. Although the magnitude of effect

was relatively small, results suggest the relevance of the control of psychological stress to the non-therapeutic management of high blood pressure.

In a recent study, 200 men who have worked at stressful jobs for at least 25 years are interviewed. The study shows that there is a 4.8 points rise in systolic blood pressure when the men are at work and a 7.9 point rise when the men are at home (Landsbergis *et al*., 2003).

Air traffic controller tend to develop high blood pressure at almost six times the rate of people in lower stress jobs (McGowan and McGowan, 2001). A study in Rahata taluka among 90 police men reveals that majority of policemen (88.89 per cent) were having moderate level of stress. Role overload and responsibility for person are moderately stress producing factors among all ranks. Stress score is significantly high among overweight (137), diabetes (142), hypertensive (137) and depressed (118) policemen. Thus occupational stress is the risk factor for development of obesity, diabetes, hypertension and depression (Kamble and Phalke, 2011).

The research conducted so far on the effects of stress reduction seems to have a positive association with hypertension and consideration of stress management is a recommended intervention for hypertensives (Blom *et al*., 2012).

C. Alternative method of treatment for hypertension

The prevention and management of hypertension are major public health challenges worldwide. If the rise in blood pressure with age could be prevented or diminished, much of hypertension, cardiovascular and renal disease, and stroke might be prevented. A number of important causal factors for hypertension have been identified, including excess body weight, excess dietary sodium intake, reduced physical activity, inadequate intake of fruits, vegetables, and potassium, and excess alcohol intake. To prevent blood pressure levels from rising, primary prevention measures should be introduced to reduce or minimize these causal factors in the population, particularly in individuals with prehypertension. A population approach that decreases the blood pressure level in the general population by even modest amounts has the potential to substantially reduce

morbidity and mortality or at least delay the onset of hypertension (Bethesda, 2004).

Many studies have shown that promoting the adoption of healthy lifestyles, best practice of diet and exercise can be the non-pharmocological treatment methods that reduce the incidence of hypertension and its associated risk factors (Dodani *et al*., 2011).

a. Dietary approach to hypertension

Hypertension is considered a serious health problem and diet can play an important role in its prevention and treatment (Figuero *et al*., 2011). In recent years, functional food had attracted considerable interest as potential alternative therapies for treatment of hypertension, especially for prehypertensive patients, whose blood pressure is marginally or mildly high but not high enough to warrant the prescription of blood pressure-lowering medications (Chen *et al*., 2009).

According to Wang *et al*., (2009) the carbohydrate and sodium are the risk factors of hypertension, but protein, riboflavin, niacin, calcium, phosphorus, zinc, magnesium, potassium and iron are the protective factors for hypertension.

Blood pressure is determined by cardiac output and peripheral resistance, peripheral vascular resistance is inversely related to the blood vessel lumen. Short term factors such as contraction-relaxation responses, and long-term factors, such as vascular remodeling, affect vascular resistance and, thus, blood pressure. Intracellular potassium and its handling are key factors in vascular smooth muscle cell relaxation and proliferation (Delgado, 2004).

Dietary interventions, in particular those based on sodium or potassium intakes, have demonstrated their ability to reduce blood pressure in humans. Recent data from the observational studies reviewed provide additional support for the sodium-to-potassium ratio as a superior metric to either sodium or potassium alone in the evaluation of blood pressure outcomes and incident hypertension (Perez and Chang, 2014).

There is strong evidence that potassium lowered blood pressure, whether consumed in foods primarily as potassium bicarbonate, or as dietary supplement in the form of potassium chloride or other potassium salt. Specifically, potassium has been noted to reduce both Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) in people with normal and high blood pressure. Blood pressure lowering effect of potassium is greatest in those that need it most, those with hypertension, those who are salt-sensitive and those who consume the most sodium (Macgregor, 2008).

Potassium also reduces salt sensitivity, an independent risk factor for heart disease. Even without diagnosed hypertension, salt-sensitive individuals may experiences spikes in blood pressure when they eat salty foods. Eating enough potassium –rich foods reduces or prevents the blood pressure response to dietary sodium, possible by stimulating excretion of sodium chloride, or inhibiting sympathetic nerve response (Ando *et al*., 2010).

Following DASH (Dietary Approach to Stop Hypertension) diet which is rich in fruits, vegetables and low fat dairy foods result in significant reduction of 5.5/3.0 mm Hg. When it combines with low level of sodium intake demonstrates even greater reduction in blood pressure. Other research has demonstrated that 4,700 mg potassium per day prevents the blood pressure raising effects of dietary sodium in both hypertensive and normotensives. DASH diet has been also shown to improve neurocognitive function among sedentary and overweight or obese individuals with prehypertension and hypertension (Smith *et al*., 2010).

Houston (2013) opines that numerous epidemiologic, observational, and clinical trials have demonstrated a significant reduction in blood pressure with increased dietary K^+ intake in both normotensive and hypertensive patients. The average blood pressure reduction with a K^+ supplementation of 60 to120 mmol/d is 4.4/2.5 mm Hg in hypertensive patients but may be as much as 8/4.1 mm Hg with 120 mmol/d (4700 mg). In hypertensive patients, the linear dose-response relationship is 1.0 mm Hg reduction in SBP and 0.52 mm Hg reduction in DBP per 0.6 g/d increase in dietary K^+ intake that is independent of baseline dietary K^+

ingestion. The response depends on race (black > white) and sodium, magnesium, and calcium intake. Alteration of the K^+/Na^+ ratio to a higher level is important for both antihypertensive as well as cardiovascular and cerebrovascular effects. If the serum K^+ is <4.0 mEq/L, there is an increased risk of CVD mortality, ventricular tachycardia, ventricular fibrillation, and heart failure.

The potassium citrate has the same blood pressure lowering effect as potassium chloride, which has been proven in the past to lower blood pressure. Potassium chloride, however, must be taken as a dietary supplement, whereas potassium citrate is found naturally in many foods. The foods rich in potassium citrate include bananas, citrus fruits, dried apricots, fish, green leafy vegetables, legumes, melons, potatoes, poultry, tomatoes, whole grain cereals and yogurt (www.health.harvard.edu).

A recent review of thirty-three studies examined the effect of potassium on blood pressure, and researchers discovered that participants who added 2,340 mg of potassium daily (from foods, supplements, or both) were able to lower their risk of developing high blood pressure by 25 percent (Adams, 2009). Mierlo *et al*., (2010) state that increase in potassium intake to 4.7 g/d would shift the population SBP distributions to 1.7 to 3.2–mm Hg lower levels.

Different regional studies indicate the noteworthy association between dietary pattern and hypertension. They find that a traditional pattern, which was rich in fish, native sea and land animal food, was inversely associated with SBP whereas a western diet was positively associated with SBP. Another study reports that an olive oil and vegetable pattern is inversely associated with SBP. Healthy pattern with high loading of green-yellow vegetables, healthy-protein foods, seaweeds, and bonefish was inversely related to the risk of hypertension (Shi *et al*., 2012). The eating lots of sulfur rich vegetables such as garlic and onions may help protect against hypertension (Yang *et al*., 2008).

Many researchers have reported that Gamma Amino Butyric Acid (GABA) has several physiological functions, especially acting as an antihypertensive. The high GABA content in brown rice can prevent the increase of blood pressure. The

purple corn could be useful in designing health-management programs for hypertension and so on (Ranilla *et al*., 2009). The solution produced by enzyme from corn protein has anti-hypertensive activity and obtained five Angiotensin Converting Enzyme (ACE) inhibitor peptides (Li *et al*., 2006).

A clove of garlic a day for 12 weeks has great effects in the treatment of hypertension. Aged garlic extract is superior to placebo in lowering systolic blood pressure (Ried *et al*., 2010).

More recently, scientific analysis has shown that coconut water is comparatively rich in both sodium and potassium ions but the concentration of potassium ions is more than twice that of sodium. Overall, 71 per cent of subjects receiving coconut water show significant decreases in the systolic pressure. Also for this group, the diastolic pressure decrease significantly in 29 per cent of the subjects (Alleyne *et al*., 2005).

Kumar *et al*., (2012) suggested that bananas are one of the best sources of potassium, an essential mineral for maintaining normal blood pressure and heart function. A medium-sized banana provides 350 mg of potassium. The effectiveness of potassium-rich foods in lowering blood pressure has been demonstrated by a number of studies. The team studied six popular banana varieties and found that all had ACE-inhibiting properties, though the ripened bananas had a stronger action than unripe ones. Researchers have reported that blood pressure fell by 10 per cent in people who ate two bananas daily for a week reduce the risk of blood pressure and stroke.

In an animal study, Dikshit *et al*., (2015) demonstrates that methanol extract of central stem of banana has significant antihypercholesterolemic and anti-oxidant effect which is positively associated with hypertension.

Although an individual serving of fresh banana is nutritionally similar to a serving of dried powder, the powder is much concentrated by volume. A 100-gram portion of banana powder contains 1,491 mg of potassium, which is 1,333 mg more potassium than the same amount of fresh banana. Dehydrated powder also

contends higher concentrations of iron, zinc and niacin compared to fresh bananas (www.healthyeating.sfgate.com).

ACE is a key component in the Renin Angiotensin Aldosterone System (RAAS) which regulates blood pressure. As the over expression of RAAS is associated with vascular hypertension, ACE inhibition has become a major target control for hypertension. Research on ACE inhibitors is expanding broadly and most are focused on natural product derivatives such as peptides, polyphenolics, and terpenes. Naturally occurring falvanoids in apple skin extract (ASE) has a potential to be used as mild or moderate ACE inhibitors. The effect of flavonoids were higher than that of the prescribed drugs for hypertension, flavonoids could be used as preventative nutraceuticals over hypertension rather than using as therapeutic drug for hypertension (Balasuriya and Rupasinghe, 2011).

Kim *et al*., (2011) opine that food is not only considered as a source of energy and nutrients necessary to maintain the proper functions of a body. Researchers are currently trying to discover new features of food components which may help to prevent many “diseases of civilization.” The diversity of protein sequences which exist in nature can produce many peptides suitable for the regulation of blood pressure. Dairy products are a well-documented source of bioactive peptides, which include the ACE inhibitors. They are found in ripening cheeses, sour milk, and fermented milk products such as dahi and yogurts (Iwaniak and Dziuba*,* 2009*).* ACE inhibitory peptides can be found outside fish marine sources, such as giant jellyfish. It is regarded as a traditional food in East Asian countries to treat asthma and hypertension.

Nezhad *et al.,* (2012) reveal that daily intake of 500 mg supplementary vitamin C (250mg twice daily) may have beneficial effects on blood pressure and thus reducing the risk of complications. In a short term (4 week) study results show that pomegranate juice reduced blood pressure and one of the mechanism of action of pomegranate juice is ACE inhibition (Mitsiou, 2013).

Fiber is the number one elixir of health. Studies on the effects of dietary fiber on blood pressure and found that a high-fiber diet was associated with a significant

reduction in blood pressure levels among people with high blood pressure or hypertension (Langston, 2011). Streppel *et al*., (2005) found that fiber supplementation (average dose, 11.5 g/d) changed SBP by -1.13 mm Hg and diastolic BP by -1.26 mm Hg. Reductions in BP tended to be larger in older (>40 years) and in hypertensive populations than in younger and in normotensive ones.

Soybeans and soy-based foods are known for their high quality protein. Soybean components, including proteins, are able to reduce cholesterol levels as well as chronic disease risks such as diabetes, obesity, and vascular diseases. The primary structures of many pea and mung bean proteins contain fragments used to form products useful in the treatment and prevention of human diseases. A study results showed that alkalase hydrolysate of mung bean protein was able to inhibit the ACE. Another study indicates that mung-bean protein is a good precursor of ACE inhibitors and alkalase hydrolysates of this plant have the potential to be utilized to produce functional foods with antihypertensive activity (Iwaniak *et al*., 2014).

Buendia *et al*., (2014) observe that higher protein intakes are associated with lower mean SBP and DBP. Both animal and plant proteins lower blood pressure and led to statistically significant reductions in high blood pressure risk. Participants in the highest total protein intake have 40 per cent less risk of developing high blood pressure. Beneficial effects of protein are apparent for men and women and for normal–weight and overweight individuals. Higher protein diets also characterize by higher fiber intakes lead to a 59 per cent reduction in high blood pressure risk.

According to Alonso *et al*., (2006), Mediterranean cohort study conducted in Spain, observed that vegetable protein and fiber from cereal were inversely associated with the risk of hypertension. It has been observed that protein intake could result in higher concentrations of some amino acids that could have a favourable effect on blood pressure.

The American Heart/Stroke Associations (AHA/ASA), the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7), the Canadian Hypertension Education Program, and the European Society for Hypertension recommend diet and lifestyle approaches as a primary means for prevention and treatment of hypertension. Each recommends increasing the intake of dietary pulses (low-fat, dry seeds of leguminous plants such as beans, peas, chickpeas, and lentils, which are distinct from leguminous high-fat oil seeds such as soy or peanuts) as part of a dietary approaches to stop hypertension (DASH) diet to lower blood pressure (Joint WHO/FAO committee, 2007).

Dietary pulses are generally consumed whole as boiled, canned, or dried foods or are ground into flour and incorporated into baked goods. Dietary pulses have a low glycemic index and saturated fat content and are high in fiber, potassium, and plant protein, each of which independently confers blood pressure lowering effects. This systematic review and meta-analysis of 8 isocaloric dietary pulse intervention trials in 554 participants support existing dietary guidelines to increase the intake of dietary pulses (beans, peas, chickpeas, and lentils) as part of a dietary strategy to achieve optimal blood pressure (Hackam *et al*., 2013).

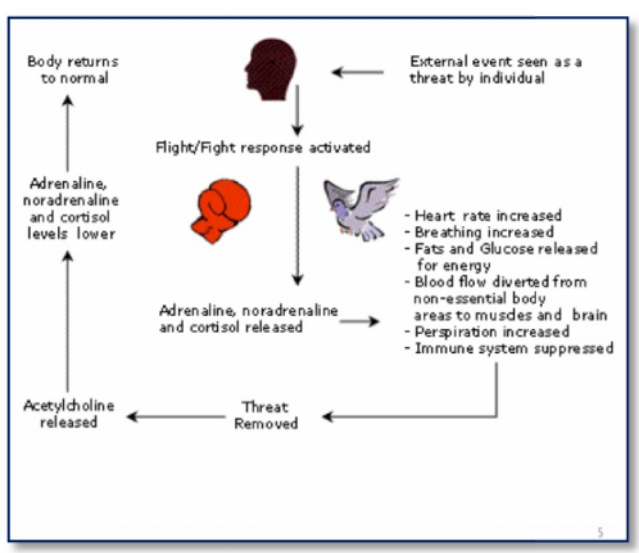
A median of $1^2/_3$ servings/day (~162g/d) of dietary pulses significantly lowered systolic blood pressure by 2.25mm Hg over a median 10-week follow-up in middle-age participants with or without hypertension in the context of a range of metabolic phenotypes (normal weight, overweight, obese, premetabolic syndrome, and type 2 diabetes (Jayalath *et al*., 2014). The exact mechanisms for the blood pressure reduction associated with bean intake are not known. Beans specifically are good sources of potassium and magnesium, which may reduce BP and by virtue of their low GI are likely to result in lower postprandial insulin levels, associated with reduced salt retention and lower BP (Jernkins *et al*., 2012).

Ha *et al*., (2014) observes the diets emphasizing dietary pulse intake at a median dose of 130g /day significantly lowered LDL cholesterol levels compared with the control diets.

Available evidence indicates that dietary factors have a prominent and likely predominant role. In individuals without hypertension, dietary changes reduce blood pressure and prevent hypertension, thereby lowering the risk of blood pressure related complications. Indeed, even a small reduction in blood pressure, if applied to an entire population, could have a tremendous beneficial impact. It has been estimated that a 3 mm Hg reduction in SBP should lead to an eight per cent reduction in mortality from stroke and a five per cent reduction in mortality from coronary heart disease. In stage I hypertension, dietary changes can serve as initial therapy before the start of blood pressure medication. Among hypertensive individuals who are already taking medication, dietary changes can further lower blood pressure and facilitate step down of drug therapy (Appel, 2009).

b. Yoga and hypertension

Yoga represents a body of practices with an ancient history originally derived from India. In Sanskrit, the word yoga derives from yug meaning to yoke, referring to the discipline of aligning the mind and body for spiritual goals. Yoga has also been practiced for potential health benefits, with increasing attention in popular culture to prevent illness and treat disease. The definition of yoga encompasses a variety of practices which may include postures asanas, breathing exercises (pranayama), meditation, mantras, lifestyle changes (e.g., diet, sleep, hygiene), spiritual beliefs, and/or rituals (Birdee *et al*., 2008).



Physiology of stress

A large body of research suggests that yoga is associated with enhanced mood and reduced stress. Numerous references and sources discuss a relationship between hypertension and stress as well as a relationship between relaxation techniques and stress. Chronic stress increases blood pressure. This is demonstrated by the fact that during a period of stress, the body

releases the hormones epinephrine (adrenaline) and cortisol, which increase high blood pressure by narrowing the blood vessels and increasing the heart rate. Also, prolonged stress causes resistance and exhaustion. In a recent study, 200 men who had worked at stressful jobs for at least 25 years shows that there is a 4.8-point rise in SBP when the men are at work and a 7.9-point rise when the men are at home (Vaidyanathan, 2015).

Regular physical activity at least 30 to 60 minutes most days of the week can lower blood pressure by 4 to 9 millimeters of mercury. In prehypertension, exercise can help to avoid developing full-blown hypertension. Trying to squeeze all exercise in on the weekends to make up for week day inactivity isn't a good strategy. Those sudden burst of activity could actually be risky (www.mayocliinic.com). The laughter therapy is an excellent type of exercise which controls blood pressure by reducing the release of stress related hormones and brings about relaxation (www.ukessays.com). Meditation is the practice of focused attention. It calms the mind, relaxes the body, and reduces stress. In a recent study states that meditation lowered blood pressure in a group of students at high risk for developing high blood pressure (Hirsch, 2014)

The most commonly performed practices of *yoga* are physical postures (*asanas*), breathing exercises (*pranayama)*, and meditation (*dhyana)*. *Asanas* are physical postures which stretch and strengthen different parts of the body, massaging and bringing fresh blood to the internal organs while rejevunating the nervous system and lubricating the joints, muscles, and ligaments. Each *asana* is purported to have different effects. Some are stimulatory to the nervous and circulatory systems, some develop coordination and concentration, while others have a calming effect on the body. Some postures such as the corpse pose, are used for elongated periods of relaxation. *Pranayama* consists of a variety of techniques for the regulation of breathing, usually by encouraging it to become slower, more regular, and more refined. The ultimate aim of yoga is to prepare the body to achieve tranquility of the mind (Arora and Bhattacharjee, 2008).

Yoga leads to an inhibition of the posterior or sympathetic area of the hypothalamus, thus, optimizing the body's sympathetic responses to stressful

stimuli, and restores autonomic regulatory reflex mechanisms associated with stress. Activity of the parasympathetic system may increase or remain unaffected. It is also well known that the hypothalamus and the limbic system are intimately concerned with emotional expressions. Yogic practices inhibit the areas responsible for fear, aggressiveness, and rage, and stimulate the rewarding centers in the median forebrain and other areas, leading to a state of bliss and pleasure. This results in lower anxiety, heart rate, respiratory rate, blood pressure, and cardiac output in persons practicing yoga and meditation than in controls (Vijiyalaksmi *et al*., 2004).

Wolff *et al*., (2013) demonstrates that a significant reduction in DBP of 4.4 mm Hg in the hypertensives who practiced yoga for 12 weeks at home compared to the control group. They also showed a greater improvement in quality of life than the control group. It is well known that physical activity has a blood pressure lowering effect. For those patients who are not able or willing to do demanding exercise, an easy yoga program could be an alternative.

Sugawars *et al*., (2010) observe that Seventeen apparently healthy adults (23 to 42 years of age) watched 30 minutes of a comedy results in significant increase in Ischemia-induced brachial artery flow-mediated vasodilation (17 per cent) and increase in carotid arterial compliance (10 per cent) and returned to baseline 24 hours after the watching. Comedy-induced changes in arterial compliance are significantly associated with baseline flow-mediated dilation. These results suggest that mirthful laughter elicited by comic movies induces beneficial impact on vascular function.

Yoga therapy is a multifunctional exercise modality with numerous benefits. Not only does yoga reduce high blood pressure but it has also been demonstrated to effectively reduce blood glucose level, cholesterol level, and body weight, major problems affecting the American society. The integrative review suggests to implement yoga as a complementary treatment of high blood pressure (Okonta, 2012).

Singh *et al*., (2008) shows a significant decrease in Total Cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL) and very low density lipoprotein

(VLDL) with a significant increase in high density lipoprotein (HDL) level from its initial value after forty five days of yoga-asanas and pranayamas. He also observed significant reduction blood glucose level.

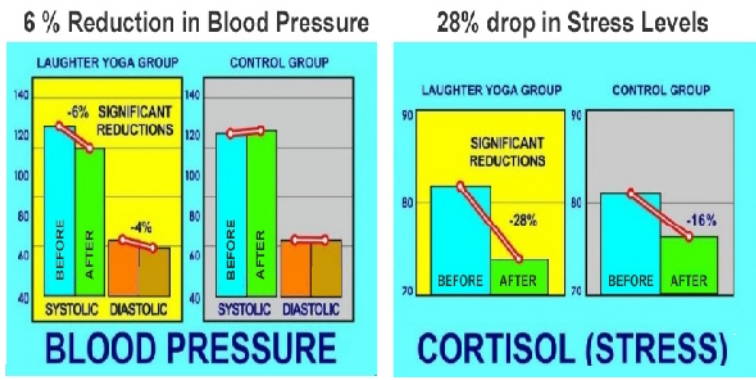
Cohen (2013) quotes that eight week pranayama and asana yoga program conducted in 27 untreated hypertensive patients living in Thailand reduces SBP by 25 mm Hg at 8 weeks and DBP decreases by 18 mm Hg in the experimental group. In India, 33 hypertensive adults are randomly assigned to 3 groups (yoga, medications only, or no therapy) and are followed for 11 weeks. At the end of the study, SBP is reduced by an impressive 33 mmHg. The differences are significant compared to both control and drug treatment. In an older randomized controlled trial from England, 43 patients with known hypertension, most of whom are already medically treated, are randomized to yoga and results in reduction in SBP by 26 mm Hg .

The concept of Laughter Yoga is based on a scientific fact that the body cannot differentiate between fake and real laughter. One gets the same physiological and psychological benefits. (www.laughteryoga.org)

Laughter decreases stress hormones and acts to buffer the effects of stress on the cardiovascular system. Studies have argued that vigorous laughter can product heat, swear and stress relief similar to the results of aerobic exercise. These cardiovascular changes have been investigated via blood pressure and particular the vascular endothelium. Many studies have been conducted recently around the world, investigating stimulated laughter program. From Tehran to Canada to Korea researchers are just beginning to investigate the healing effects of laughter on the body and mind. Though gelotology is still in its infancy, laugher programs have garnered world wide popularity, particularly the laughter club movement (Chang *et al*., 2013).

According to a new study presented at the American Society of Hypertension 2008 Annual Meeting, laughter in the context of laughter yoga can significantly lower blood pressure and reduce cortisol, or stress hormone levels. Laughter yoga is a combination of laughter exercises, gentle yoga breathing, and

stretching. The investigators of the study evaluated 200 people, both men and women, working in the information technology industry in India. These individuals participated in seven 20-30 minute laughter yoga sessions, where they alternated 45 seconds to one minute of laughter with deep breathing and stretching exercises. After three weeks, the investigators observe that laughter yoga participants experienced significant reductions in their baseline blood pressures, as well as their cortisol levels (Chaya *et al*., 2008).



Kaspar *et al*., (2012) observe that the 20-minute laughter intervention involved breathing and stretching exercises, simulates laughter (ie, unconditional laughter that is not contingent on the environment), chanting, clapping, and a meditation show improved immediate mood (vigor-activity and friendliness) and increase heart rate variability and blood pressure after the laughter intervention.

Even if the effects of yoga on hypertension are modest this can still provide substantial cardiovascular protection for the group of patients with mild to moderate hypertension and may afford patients the opportunity to engage in yoga instead of committing to lifelong antihypertensive medication.